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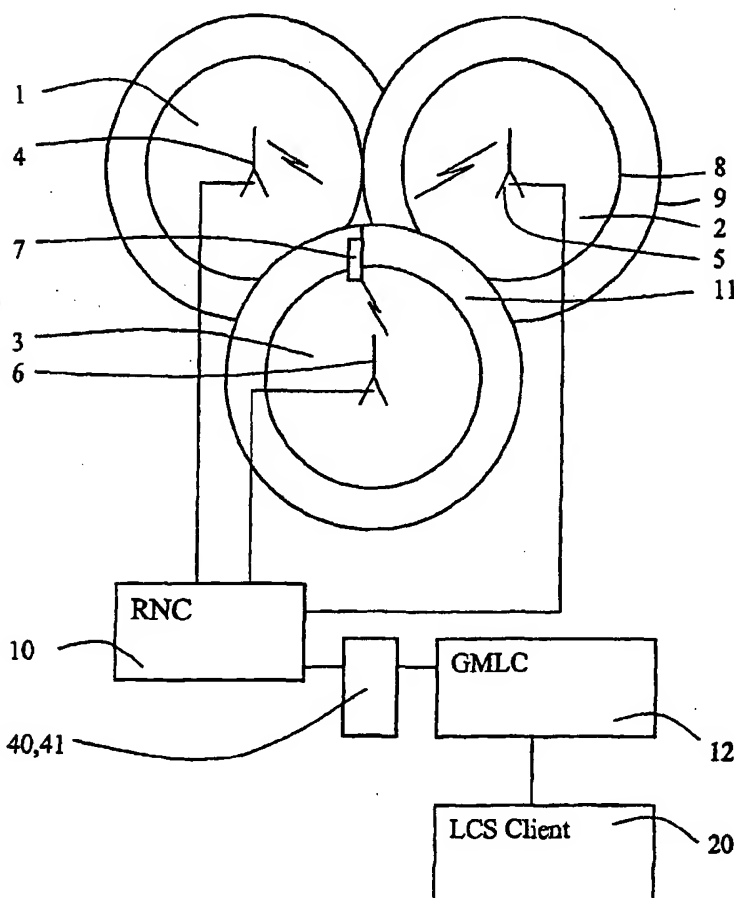
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(54) Title: LOCATION OF A MOBILE STATION IN A TELECOMMUNICATIONS SYSTEM



(57) Abstract: The present invention relates to a telecommunications system and a method for use in a telecommunications system. The telecommunications system comprises a plurality of service areas, each of the service areas being identified by a service area identifier. In accordance with the method a service area identifier is requested that associates with a mobile station. Upon receipt of the request, one service area identifier is selected from a plurality of possible service area identifiers. A predefined rule for the selection of the service area identifier is used for the selection. Location information that associates with the mobile station is then provided based on the selected service area identifier.

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LOCATION OF A MOBILE STATION IN A TELECOMMUNICATIONS SYSTEM

Field of the Invention

- 5 The present invention relates to telecommunications system and in particular, but not exclusively, to a wireless cellular telecommunications network.

Background of the Invention

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- A cellular telecommunications system is based around cells or similar radio coverage or service areas. Examples of cellular telecommunications systems include standards such as the GSM (Global System for Mobile communications) or various GSM
- 15 based systems (such as GPRS: General Packet Radio Service), AMPS (American Mobile Phone System) or DAMPS (Digital AMPS) or WCDMA (Wideband Code Division Multiple Access) and TD/CDMA in UMTS (Universal Mobile Telecommunications System) and so on. In general, a cell coverage area or a base station
- 20 coverage area of a cellular telecommunications system can be defined as a certain geographically limited area served by one or several base stations (BTS in GSM, Node B in UMTS). A base station serves mobile stations or similar terminal apparatus (MS in GSM, User Equipment, UE in UMTS) via an air
- 25 or radio interface. The size of the cells varies remarkably depending on the type of environment. For example, at the present the smallest cells are only some tens of meters in diameter while the largest cells may be kilometers in diameter. The shape of the cells may also vary from cell to
- 30 cell. Several cells may also be grouped together to form a larger service area.

Each of the cells can be controlled by an appropriate controller apparatus. For example, in the WCDMA radio access network the cell is served by Node B, which is connected to and controlled by the radio network controller (RNC). In the
5 GSM radio network the cell is served by BTS, which is connected to and controlled by the base station controller (BSC). The BSC/RNC is connected to and controlled by a mobile switching center (MSC) and may in addition be connected to and controlled also by the serving GPRS support node (SGSN).
10 The MSCs of a mobile network are interconnected and there is one or more Gateway MSC (GMSC), which connects the mobile network to the public switched telephone network (PSTN) and other telecommunication networks. The SGSN is connected to a Gateway GPRS support node (GGSN), which connects the mobile
15 network to the Internet and other packet switched networks. Several cells cover a larger area, and form together the coverage area of a cellular telecommunications network.

The mobile station within one of the cells of the
20 telecommunications system is correspondingly served by the base station and controlled by the controller of the base station. The MS/UE may be in communication with two or more base stations at the same time. The two or more base stations may be connected to the same controller or different
25 controllers. Thus, although the UE may be served by only one base station and controller at the time, it may also be connected simultaneously to several base stations and/or controllers. This may occur e.g. when the coverage areas of the cells overlap or when the mobile station is in so called
30 soft handover mode between the cells. One of the controllers may act as a serving (main) controller whereas the other may act as a secondary controller.

The cellular telecommunications system may be divided into so called core network and access network sides. The arrangement may be such that the base stations and the related controllers belong to the access network thereby providing
5 cell level features of the system. The core network then provides network level services, such as links the access networks towards the other parts of the telecommunications system. An appropriate interface, such as the so called Iu interface, is provided between the access network and the
10 core network.

The cellular network apparatus can also be employed in the context of the location of a mobile station and thus the user thereof. More particularly, the cells or similar
15 geographically limited radio coverage areas and associated controllers may facilitate the cellular telecommunications system to produce at least a rough location information estimate concerning the current location of a mobile station, as the cellular telecommunications system is aware of the
20 cell or service area with which a mobile station currently associates. The information about the cell the mobile station associates with may be obtained, for example, by paging, locating area update, cell update, URA update, or routing area update. The cell coverage based location information can
25 be indicated as a cell identity of the used cell, as a Service area identity or as geographical co-ordinates of a location that relates to the serving cell. The location information may include a QoS (Quality of service) estimate (e.g. regarding achieved accuracy). When geographical co-
30 ordinates are used as the location information, the estimated location of the mobile station may be a fixed geographical location within the serving cell (e.g. location of the serving node-B), the geographical centre of the serving cell

coverage area, or some other fixed location within the cell coverage area. The geographical location can also be obtained by combining information on the cell specific fixed geographical location with some other available information, such as the signal Round Trip Time (RTT).

Therefore it is possible to conclude the cell or geographical service area within which the mobile station is likely to be at a given moment. This information is available also when the mobile station is located within the coverage area of a visited or "foreign" network. The visited network may be made capable of transmitting the location of the mobile station back to the home network, e.g. to support location services or for the purposes of routing and charging.

A location service may thus be based on the cell coverage or service area. According to a more specific proposal the cellular communications system may provide the last known location of a mobile station together with a time-stamp. The location service feature may be provided by a separate network element or server which receives the location information from the controllers of the system. For example, in the GSM this information can be obtained from a Visitor Location Register (VLR) of the visited MSC or the Home location Register (HLR) of the home network. This proposal would give the location to an accuracy of one cell, i.e. it would indicate that the mobile station is (or at least was) within the coverage area of a certain cell.

The service area, such as a cell and/or a base station coverage area is typically identified by an appropriate identifier so that the system may distinguish the areas from each other. Both the mobile station and the controller are typically informed of the current identifier. It is to be

appreciated that said identifier indicating the current cell and/or base station may be referred to by various terms, such as cell ID or location area identity (LAI) or service area identity (SAI). The following specification uses the term
5 'service area identifier' to refer to all such identifiers that relate to an area that is served by an element of a telecommunication system, such as by a cell or a group of cells or a base station or a group of base stations.

10 It is possible that several service area identifiers associate simultaneously with a mobile station. This may occur, for example, when the cell coverage areas overlap or the mobile station is in so called soft handover state between the cells and thus in communication with more than
15 one base station. Thus a location service that is based on information of service areas may receive more than one identifier. The inventors have found that this may lead in certain circumstances to a undefined situation where the location service may not be able to provide as accurate
20 location information as it could provide if it had received only one identifier. In addition, the location service may not be capable at all to process location information data that is based on two (or more) different identifiers.

25 Summary of the Invention

It is an aim of the embodiment of the present invention to address one or several of the above problems.

30 According to one aspect of the present invention, there is provided a method for use in a telecommunications system, said telecommunications system comprising a plurality of service areas, each of the service areas being identified by

a service area identifier, the method comprising the steps of:

- requesting a service area identifier associated with a mobile station of the telecommunications system;
- 5 selecting one service area identifier from a plurality of possible service area identifiers in accordance with a predefined rule for the selection of the service area identifier; and
- 10 providing the location information based on the selected service area identifier.

According to another aspect of the present invention there is provided a telecommunications system, comprising:

- a plurality of service areas, each of the service areas
- 15 being provided with a service area identifier;
- a location service node arranged to requests a service area identifier associated with a mobile station and to provide location information concerning the mobile station based on the service area identifier; and
- 20 selection means that are arranged to select one service area identifier associated with the mobile station from a plurality of possible service area identifiers associated with the mobile station in accordance with at least one predefined rule for the selection of the service area
- 25 identifier.

The embodiments of the invention may provide a simple solution in which only one service area identifier is provided for a location information service node. The

30 accuracy of the location information may be improved in some instances. For example, instead of providing a service area identity (SAI) covering several cells to the location services, the system may instead select and provide a cell

identifier. The selection of the service area identifier is preferably accomplished at the access network side by an appropriate element, and the location service node at the core network side of the system is then preferably provided with the selected identifier. Thus any unnecessary signalling of information between the core network and the access network may be avoided. The information is preferably always available at the access network side. Thus, in some embodiments of the invention, a location information request from the core network can be responded with no substantial delays since no additional measurements may be required for generating the response.

Brief Description of Drawings

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For better understanding of the present invention, reference will now be made by way of example to the accompanying drawings in which:

Figure 1 shows a schematic diagram of three cell coverage areas of a cellular telecommunications system in which the embodiments of the invention may be implemented;

Figure 2 shows two radio coverage areas provided by sector antennas;

Figure 3 illustrates one possible functional diagram for a location server;

Figure 4 shows in more detail a possible network architecture in accordance with an embodiment of the invention;

Figure 5 is a flow chart for a possible process for determining a service area identifier;

Figure 6 show a cell arrangement that may be used when implementing the invention; and

Figure 7 illustrates possible states of a mobile station in a telecommunications system.

Description of Preferred Embodiments of the Invention

5
Reference will first be made to Figure 1 in which three base stations provide omnidirectional radio coverage areas 1, 2 and 3 of a cellular telecommunications network. Even though the exemplifying telecommunications network shown and
10 described in more detail uses the terminology of the WCDMA (Wideband Code Division Multiple Access) UMTS (Universal Mobile Telecommunications System) public land mobile network (PLMN), it should be appreciated that the proposed solution can be used in any cellular system providing both
15 communications between a mobile station and a base station and some kind of location information service. In addition, one cell may include more than one base station and a base station apparatus may provide more than one cell.

20 In Figure 1 each radio coverage area 1, 2 and 3 is served by the respective base station (Node B or BTS) 4, 5 and 6. More particularly, each base station is arranged to transmit signals to and receive signals from the mobile station (MS, UE) 7. Likewise, the mobile station 7 is able to transmit
25 signals to and receive signals from the respective base station. The mobile station 7 accomplishes this via wireless communication with the base stations. Typically a number of mobile stations will be in communication with each base station although only one mobile station is shown in Figure 1
30 for clarity.

Each of the base stations is connected to a network controller 10, which in the exemplifying PLMN system is a

radio network controller (RNC) of a UMTS terrestrial radio access network (UTRAN). It is noted that typically more than one controller is provided in a network. The radio network controller 10 is typically connected to appropriate core network entities, such as a MSC and SGSN 40,41 via a suitable interface arrangement (see Fig. 4). The radio network controller may be connected to a GSM MCS A-interface via an A-interface/Iu interface Interworking Unit (IWU).

10 The mobile station 7 is able to move from one cell coverage area to another cell coverage area. The location of the mobile station 7 may thus vary in time as the mobile station is free to move from one location (base station coverage area or cell coverage area) to another location (to another coverage area) and also within one coverage area.

Each of the cells 1 to 3 of Figure 1 is shown to provide two radio coverage circles 8 and 9. The inner circle 8 of each cell illustrates so called reduced coverage area of the cell.

20 The outer circle 9 illustrates so called extended coverage area of the cell. The area between the circles 8 and 9 is referred to as soft handover area 11. Whenever the mobile station 7 is within the soft handover area 11, it may receive more than one cell and may be in signaling communication with more than one signal branch from the respective base stations. As a result of the macrodiversity, the mobile station may simultaneously associate with more than one cell identifier. According to an estimate the percentage of time that a mobile station may be located within a soft handover area is about 30 to 40 %.

Figure 2 shows three beam shaped radio coverage areas 16, 17 and 18. Each of the disclosed radio coverage areas consist of

a sector of provided by directional or sector antennae of the base stations 14 and 15. It is noted that a sectorized base station may also provide an omnidirectional coverage area. This may be implemented e.g. by three 120° directional antennae whereby a 360° radio coverage areas is provided, or 5 four 90° directional antennae and so on, or any combinations of different radio coverage beam widths. As can be seen, the base station 14 provides two radio coverage sectors 16 and 18 which overlap at a handover area 11'. This handover area 10 between sectors 16 and 18 may be referred to as "softer" handover area. The mobile station 7 is shown to be located within a soft handover area 11 between the circles 8 and 9 of the sectors 16 and 17 as discussed above.

15 Figure 1 also shows a location services (LCS) node 12 providing location services for different applications or clients 20. In general terms, the LCS node can be defined as an entity capable of providing information concerning the geographical location of a mobile station, and more 20 particularly, the geographical location defined on the basis of the position of the mobile station relative to the base station(s) of the mobile telecommunications network. In the embodiments of Figure 1 and 4 the node 12 comprises a gateway mobile location center (GMLC) that is provided in the core 25 network side of the telecommunications system.

Figure 3 illustrates in more detail the functional diagram of the location server according to ETSI (European telecommunications Standards Institute) technical 30 specification "Location Services" (3GPP TS23.171 and GSM 03.71).

The location service node 12 is arranged to receive, by appropriate interface means 30, predefined information concerning the location of the mobile station 7. Since the telecommunications system is aware of the service area within which the mobile station is positioned, it is possible to define the geographical location of the mobile station on the basis of the service area information derived based on the identifier of that service area. The information received by the node 12 may include the identity of the mobile station 7 and the identity of the cell, or the identity of the service area (containing one cell or several cells), that is serving the mobile station. Node 12 processes this information and/or some other predefined parameters and/or computes by processor means 31 appropriate calculations for determining and outputting the geographical location of the given mobile station 7.

The location service node 12 is implemented in the core network and is arranged to receive location information from the radio access network via MSC and/or SGSN 40,41 connected by the appropriate interface means 13 to the access network. It is noted that although Figures 2 and 4 show an Iu interface between the elements of the core network and the access network element 10, the interface may be implemented by other means as well, e.g. the A-interface specified in GSM. It is also noted that the elements of the location service functionality may be implemented anywhere in the telecommunications system and that the actual location service implementation may be distributed between several elements of the system.

The LCS client 20 is a logical functional entity that makes a request to the LCS server node 12 for the location

information of one or more target mobile stations. The LCS client 20 may be an entity that is external to the PLMN. The client 20 may also be an internal client (ILCS) i.e. reside in any entity (including a mobile station) within the PLMN.

5 The LCS clients are entitled to receive at least some degree of information concerning the location (or location history) of the mobile station 7. Figures 3 and 4 schematically show the location service model in which a LCS client 20 is arranged to request location information for one or more

10 certain target mobile stations from the LCS server node 12. The LCS server node 12 obtains positioning information from the access network side that is obtained using one or more of the appropriate techniques that will be briefly discussed below or any other suitable technique. This information may

15 be processed in a predefined manner and is then provided to the LCS Client 20.

The particular requirements and characteristics of a LCS Client 20 are typically known to the LCS server by its LCS

20 client subscription profile. The particular LCS-related restrictions associated with each target mobile station may also be detailed in the target mobile station subscription profile. The location service feature may permit the location of a target mobile station to be determined at any time, as

25 will be discussed later in this description.

The LCS server node 12 may consists of a number of location service components and bearers needed to serve the LCS clients 20. The LCS server node 12 may provide a platform

30 which will enable the support of location based services in parallel with other telecommunication services such as speech, data, messaging, other teleservices, user applications and supplementary services. The LCS server node

12 responds to a location request from a properly authorized LCS client 20 with location information for the target mobile stations specified by the LCS client 20 if considerations of target mobile station privacy are satisfied. The LCS Server
5 12 may thus provide the client 20, on request, the current or most recent geographic location (if available) of the target mobile station or, if the location fails, an error indication and optionally the reason for the failure.

10 The location information may be used for several other purposes than solely for call processing (routing, charging, resource allocation, etc.), and the following are examples of possible clients. Clients broadcasting location related
15 information to the mobile stations in a particular geographic area - e.g. on weather, traffic, hotels, restaurants, or the like. Clients recording anonymous location information (i.e. without any MS identifiers) - e.g. for traffic engineering and statistical purposes. Clients enhancing or supporting any supplementary service, IN (intelligent network) service,
20 bearer service or teleservice subscribed to by the target MS subscriber. These are only examples and any other suitable clients may use the location service node. This service can of course be used to determine the location of a mobile station when it makes an emergency call. There are also
25 several other possible commercial and non-commercial applications which may use the location information provided by the location service (LCS). These possible applications include different local advertisement and information
30 distribution schemes (e.g. transmission of information directed to those mobile users only who are currently within a certain area), area related WWW-pages (such as time tables, local restaurant, shop or hotel guides, maps local advertisements etc.) for the users of mobile data processing

devices, and tracking of mobile users by anyone who wishes to receive this information and is legally entitled to obtain it. An application requiring real-time location information of the movement of a mobile station is a mobile station movement prediction feature that the network may utilize, for example, in dynamic network resource allocation. There are various other possible uses of the location information and applications, which could use the location information.

10 The LCS Server 12 shall enable a network operator to charge LCS clients 20 for the LCS features that the network operator provides.

It shall be possible for the location determining process to make use of several sources of information in determining the location. Propagation and deployment conditions may limit the number or quality of measurements or additional measurements may be possible. Some mobile stations may also have additional (independent) sources of position information of the type discussed earlier. The LCS shall be capable of making use of the restricted or the extra information as appropriate for the service being requested. The accuracy of the location determination may thus be improved by utilizing results of the various location measurement and/or determination techniques. A possibility is to define the travel time (or travel time differences) of the radio signal sent by the mobile station to the base station. According to another possibility the location determination is based on measurements accomplished by at least three different base stations covering the area in which the mobile station is currently located. Additionally, the geographical location may be obtained from a reliable external source, e.g. from the well known satellite based GPS (Global Positioning

System). More accurate location information can be obtained through a differential GPS. In addition to the GPS, any other similar system capable of providing reliable location information can be used for this. There are several other proposals for providing location information that is more accurate than the information that is based on cell coverage area. It is also possible to have a system where several different location service accuracy classes are provided, wherein the method used for the location determination depends of the requested accuracy. The required accuracy may be indicated e.g. by so called quality of service (QoS) parameters included in a location information request.

It may be possible for the LCS client 20 to specify or negotiate a (minimum) level of quality, such as minimum accuracy, in a location information request. Different applications demand different levels of positioning accuracy and other positioning performance parameters, so the levels of performance are preferably classified according to the type of applications. The quality of location information can involve parameters like accuracy, update frequency, time stamp, time-to-first-fix, reliability, continuity, etc. In case location information is not available to the required quality level, the request can either be denied and the service execution terminated, or the user accepts the lower quality information. The quality level requirement of each service (application) could be set both by the subscriber and the service provider.

The location service, e.g. the GMLC node 12 of Figure 4, is arranged to request for location information from the access network as a response to a location information request by the client 20 (LCS Request). According to a preferred

embodiment the GMLC 12 then sends the request via the gateway apparatus (MSC 40 and/or SGSN 41) and over the interface 13 to the network controller 10 in the access network. The serving controller of the access network will then determine the accuracy of the location information, select an appropriate method for the location determination, and provide the GMLC 12 with appropriate location information.

According to another embodiment, the location service, e.g. the GMLC 12 of Figure 4, determines the required accuracy upon receiving a LCS request, and selects an appropriate method for the location determination. The embodiments discussed in the following with reference to Figures 1 and 4 will consider the case where location information that is based on the cell coverage area is selected.

When the GMLC 12 requests for the location information, it may define e.g. in the quality of service (QoS) parameter the accuracy that is required. In case the accuracy is defined to correspond the cell coverage area, the core network apparatus 40 and/or 41 requests then the RNC 12 of the UTRAN side to provide the service area identifier of the targeted mobile station. According to an embodiment the service area identifier to be returned to the GMLC 12 comprises the cell identifier (cell_ID) of the cell that is currently serving the mobile station or an identifier or parameter that is derived from that cell identifier.

In accordance with an embodiment, the Service area identifier returned to the GMLC 12 comprises the estimated geographical location of the mobile station as indicated in geographical co-ordinates and including information about the estimated achieved accuracy (level).

In accordance with an embodiment, if the mobile station is positioned in the coverage area of several cells and thus associates with several identifiers, the network controller
5 10 selects one of the several identifiers to be transmitted from the access network side (UTRAN in Figure 4) to the core network as response to the request. The identifier to be transmitted to the GMLC 12 is preferably the cell identifier of the selected cell, but may also be any other parameters
10 that is based on the selection of the service area. The network controller 10 makes the selection based on a predefined rule or a set of rules, as will be discussed below. One possible flow of the decision process is illustrated by Figure 5.

15
The selection of the service area identifier is preferably made by the controller 10. However, any other network element in the network, including the mobile station 7 and a base station of the access network, may be arranged to make the
20 selection based on the predefined rules.

According to a possibility the selection of the service area identifier is based on measurements made to determine the signal power or strength between the mobile station and the
25 base stations that the mobile station may receive. After the measurements, the service area identifier associating with the strongest signal is preferably selected.

If the selection of the service area identifier is based on
30 the signal power or strength, the determination may be based on use of a reference signal. This specific embodiment may be based on one or several of the following principles:

- In a soft handover state or otherwise when there is an active set signal that includes several signal branches, a signal branch is selected and used as a reference branch as long as the selected branch belongs to the active set. If the reference branch is deleted or replaced, the cell identifier can be determined based on the second best reference signal (branch).
- The selected cell identifier can be changed (updated) as soon as a Primary Common Pilot Channel (CPICH, in WCDMA) that is not included in the active set becomes better than a Primary CPICH that belongs to the active set.
- The selected cell identifier may also be changed as soon as a Primary CPICH becomes better than the previously best primary CPICH.
- The selected cell identifier may also be changed as soon as a primary CPICH becomes better than an absolute threshold that may be based on the signal levels of the other active branches or be otherwise determined.
- The selected cell identifier may be changed as soon as a Primary CPICH becomes worse than an absolute threshold.
- The selected cell identifier may be changed as soon as a Primary Common Control Physical Channel (CCPCH) becomes better than the previous best primary CCPCH.
- The selected cell identifier may be changed as soon as a SIR (Signal to Interference) value of a timeslot becomes worse than an absolute threshold value.
- The selected cell identifier may be changed as soon as a Interference on Signal Code Power (ISCP) value of a timeslot becomes worse than an absolute threshold.
- The selected cell identifier may be changed as soon as an ISCP value of a timeslot becomes better than a certain predefined threshold.

- In general, a LCS_MARGIN may be utilized in a cell identifier determination process. The LCS_MARGIN can be based on Time-To-Trigger, pending time, power level of the signal (offset), or any similar approaches. The LCS_MARGIN may be used to prevent the unnecessary cell identifier updating to avoid the system performance to impair. The LCS_MARGIN may be applied either in forbidding or allowing the cell identifier update triggering.
- 10 An alternative is to determine signal to noise ratios (SNR) or any other parameters defining the quality of the received signal branches. Again, it is preferred, but not necessary, to base the selection on the best quality signal branch. It is also possible to base the selection on other features or parameters of the signal that may be measured or detected for the received signal branches.

The closest base station of the several base stations may also be determined, and to use this information as a base of the selection. The distance between the mobile station and the base stations can be determined, for example, based on the time of arrival of the radio signal sent by the mobile station at the base stations, or vice versa. Another example is so called round trip time (RTT) method. The travel time of the signal at any particular base station is related to the distance travelled given by formula:

$$R = cT, \quad [1]$$

wherein

- 30 R = mobile to base station distance (range)
 c = the speed of light, and
 T = the travel time of the radio signal.

The distance information can also be based on measurements made at the receiving station to determine the signal strength, signal to noise ratio or any other such feature of the received signal from which it is possible to determine the distance between the transmitting station and the receiving station.

It is noted that the measurement of the feature of the radio signal can be accomplished both in the uplink and/or in the downlink, i.e. at the base station end or at the mobile station end or at both. In case the mobile station is used for the measurements of the signal, it may use e.g. the control channels of the radio network for sending the measurement results to an appropriate network element. The necessary calculations and determinations based on various collected/defined data can be accomplished at the station (base station or the mobile station) or at an appropriate network element, such as at the network controller 10, having an access to all required data.

Whenever the selection decision is based on measurement of one or several features of the signals between the mobile station and the respective base stations, it may happen that the measured feature, such as the signal strength or quality, changes rapidly. Therefore it may be advantageous to define a determination window or interval and to determine an average for the feature. The average will then be compared against the corresponding averages for the other signal branches, and the selection is made based on this comparison.

According to one possibility, the service area identifier to be selected is the service area identifier generated when the mobile station was successfully paged for the last time

during connection establishment procedures. This may typically be applied in mobile station terminated calls. The service area identifier to be selected may also be the service area identifier that was generated during connection
5 set-up proceedings between the mobile station and the serving base station. This may typically be applied in connections that are initiated by the mobile station.

According to one possibility the service area identifier to
10 be selected is the oldest service area identifier the mobile station associates with. According to another possibility the service area identifier to be selected is the most recent service area identifier the mobile station associates with. The most recent service area identifier may be the identifier
15 of the cell to which the mobile station has been recently handed over from a previous cell, or the identifier of the latest "new" cell that the mobile station has started to receive, but has not yet been handed over to. The service area identifier to be selected may also be the service area
20 identifier of the cell that provides an active connection for the mobile station at the time of receiving a new LCS request at the network controller.

In accordance with a possibility the cells or other service
25 area is selected from the plurality of possible service areas based on a preference or priority order.

As shown by Figure 5, it is possible to employ more than one rule in the selection process. When more than one rule is
30 employed, the controller is provided with further rules that define the relation between the selection rules. For example, it shall be possible to define threshold levels for one or several parameters of the rules. For example, before

selecting a rule that is based on the distance between the mobile station and the base station, the distance has to be smaller than a predefined threshold distance. According to another example, a rule that is based on the signal strength measurements is not used unless the measured strength or strengths exceed a predefined threshold value. One possible threshold parameter may define maximum or minimum size of the cell or another service area. Line of sight (LoS) condition may also be used in this context.

According to a possibility the rules are set in an order of preference i.e. in a priority order. In this approach the controller follows the rule selection algorithm or tree until either a service area identifier is selected based on a rule of the subsequent rules or the request has been subjected to last possible selection rule. If even the last possible rule cannot provide the identifier, the GMLC 12 is then preferably informed of this, and the client 20 is provided with an appropriate message.

It is noted that Figure 5 discloses only one example of the predefined order of the rules, and that the order and/or number of rules may differ from this. In addition, the relations between the rules may vary, e.g. in relation to time (different rules at night and day), or in relation to the load situation of the controller or network. According to a possibility a predefined rule is selected among the rules for the selection of the service area identifier in response to a predefined event. In other words, the rule to be used depends on conditions such as the type of the request, the identity of the location service node that is requesting for the location information, the identity of the client and so on.

The telecommunications system may support so called inter-mode environment applications and the above described embodiments may be used in this context as well. The inter-mode environment applications include services such as Support of Localized Service Area (SoLSA), customized applications for mobile network enhanced logic (CAMEL) and so on. The cell identifier based LCS or generally LCS may be implemented using existing toolkits such as a SIM Application Toolkit (SAT) or CAMEL. CAMEL may be used to provide cell based applications in a CAMEL Service Environment (CSE), which can be used with the SoLSA. CSE includes e.g. charging modifications and call barring based on cell information. However, since the network may be implemented by using several service platforms, CAMEL is described herein only as an example.

The embodiments may also be applied to or used in combination with other advanced positioning features of a cellular system. These include Localized Service Area (LSA) priority, LSA Only Access, Exclusive Access, Preferential Access, and so on. The inter-mode environment may include different cellular system e.g. GSM, WCDMA, etc. with multi layered cellular structures, including macro-cells, micro-cells, pico-cells, and home-cells. In the following some examples of such features are described in more detail.

LSA priority is the priority of the subscriber's LSAs. If a user has several valid LSAs at a moment a decision is made based on the LSA priority which of these will be the current LSA. In Figure 6 LSA A has higher priority than LSA B. The priority of the cells may only be compared between suitable cells. A feature of the LSA priority is that operators may

define a certain cell to be selected before another cell. For example, if a so called umbrella cell is selected before a microcell there will be less resources left due to the large frequency reuse distances of the umbrella cells.

5

In the *LSA Only Access* the user is allowed to access the PLMN only when he is within the LSAs he has subscribed to. The user is not able to receive or make any calls when he is outside his LSAs. In other words, the cell identifier may be used to block and/or allow the use of the mobile station in cell. An exclusive access cell, in turn, is a cell that cannot be used by anyone else than those users that belong to the LSA the cell belongs to.

10

15 A *preferential access cell* is a cell that belongs to a specific LSA that prefers, i.e. gives some predefined priorities to subscribers belonging to the LSA. The cell may have only limited access to non-LSA users.

20 To support the *exclusive access*, *LSA Only Access* and *Preferential Access* during an active mode of the mobile station, the LSA information is preferably available within the RNC, BSC or similar element of the access network.

25 The following will discuss an embodiment where the selected cell identifier is used in connection with a power control mechanism of a wireless telecommunications system. The cell identifier determination may be aligned with the power control mechanism such that the results of a cell identifier requests or power control commands (power adjusting) may
30 disturb each other, although they may be utilised in the operation of the other feature. For instance, if the cell identifier has been already determined, then the related

power-up commands (for increasing the power) of the other signal branches of the active connection may be ignored. Instead, power up commands of the selected cell may be valid until the selected cell is the best candidate. On the other hand, power down commands are valid only for non-candidate branches and not for the best candidate (a prioritised cell identifier). It should be appreciated that different variants of power control and cell identifier determination combinations are possible. They should be selected based on the system load, interference, radio environment, LCS requests, etc. to increase the system performance.

The cell identifier may also be employed in association with a site selection diversity power control (SSDT). Site Selection Diversity Transmit Power Control (SSDT) is a form of power control for the downlink that can be applied while a mobile station is in soft handover. According to the principles of the SSDT the best cell of the active set is dynamically chosen as the only transmitting site. In this case the cell identifier method harmonises the cell identifier determination to be based on the SSDT criteria.

In addition, the embodiment may be employed in connection with an Idle Period Downlink (IPDL). In the IPDL each base station at its turn ceases completely from transmission for a short predefined period of time, and this way provides an efficient measurement period for all the terminals within the coverage area thereof. This is accomplished in order to improve the Signal-to-Interference-Ratio (SIR) of the measurements by attenuating the strongest source of interference, that is the serving base station. The embodiments of the invention may also take into account the ceasing periods of the IPDL mechanism. This can be done, for

instance, ignoring the reference signal power ceasing periods, alignment of cell identifier updating frequency with the ceasing period frequency (e.g. if ceasing periods do not occur especially often), etc.

5

Figure 7 illustrates different possible states of a mobile terminal in a 3rd generation environment in different WCDMA radio resource control (RRC) states. The embodiments of the invention may support cell identifier based positioning in any state shown in Figure 6, including URA_PCH, Cell_PCH, Cell_DCH, cell FACH, cell reselection, inter-system modes, as well as an idle mode.

The service area identifier may not be obtained if the mobile station is not in an active state, i.e. there is no connection between the mobile station and at least one of the cells. For example, in the UMTS the cell ID can be provided only when a radio resource control (RRC) connection exists between the mobile station and at least one base station.

Therefore, it may be possible that the network controller is not able to return the service area identifier to the core networks. If the mobile station is in a mode where the cell identifier (or coverage) can not be provided then mobile station may be forced to a state where the cell identifier may be provided. For example, in a URA_PCH state the Cell identifier may not be available. The MS can be forced to Cell_FACH to define the cell identifier so that the cell identifier may be obtained whenever the LCS node needs it. Moreover, the network can prevent the MS to enter a URA update state in order to receive cell updates when the MS selects a new cell.

If the MS is in an idle mode and there is a need to page for it, then the paging triggering for LCS purposes may be originated either by the core network or the UTRAN access network. In addition to the conventional paging approaches, 5 the following possible enhancement may be applied for paging purposes:

- The latest available information about the geographical location of the MS (LCS assistance data) can be used to determine the area that should be paged first.
- 10 - The speed and direction of the MS (or any other mobility parameter) can be utilized to determine the paging area and paging repeating periods.
- In case of high speed mobiles, it is assumed that an appropriate set of latest cell identifiers (or LCS assistance 15 data) can be utilised for paging area determination.
- The cell based LCS assistance data can also be used to optimize the location area, repeating periods, and so forth.

It should be appreciated that the LCS assistance data may be 20 utilized in optimizing any paging and location updating procedures.

The cell identifier determination may be based on different LSA modes, including active and idle modes. One possibility 25 is that when determining the cell identifier the first priority belongs to a predefined one of the LSA applications (e.g. SoLSA, or any other LSA). To make the mobile station (MS) work safely in the network it may be necessary to have an idle mode support. This means that a feature may be needed 30 in MSs to enable it to reselect the right cell when camping on a cell in idle mode. The term camping means that the MS is in a idle state within a cell. The MS should always attempt to reselect a cell belonging to the subscriber's LSA. If

several cells are available, the cell with the highest priority should be reselected.

The MS may use normal cellular system methods when selecting
5 a cell (e.g. when the mobile station is switched on). This is
done e.g. by measuring and calculating a signal power
parameter for each cell the mobile station may receive,
whereafter the cell with the best power value is selected.
The reselection of the cell may be done by calculating an
10 additional parameter. The cell with, in the first place, the
highest priority and in the second place with the highest
additional parameter is reselected.

In non-LSA cells the calculation of signal power parameters
15 may include, for example, a threshold parameter
RXLEV_ACCESS_MIN, but it is also possible to use a
LCS_RXLEV_ACCESS_MIN for the LCS cells instead. Separate
parameters may be needed to ensure that the connection
quality for both LCS and normal connections in a LSA cell.
20 Another new threshold or margin parameter that may be
broadcasted to the MS is a LSA_CAMPING_MARGIN. If the value
of a parameter of a lower priority cell (or normal cell)
becomes higher than the corresponding parameter of a higher
priority cell by the margin LSA_CAMPING_MARGIN, then the MS
25 will camp to the lower priority cell even if the
LSA_RXLEV_ACCESS_MIN is still positive.

The LSA_RXLEV_ACCESS_MIN may be used to ensure that the MSs
favours the LSA cells and the LSA_CAMPING_MARGIN may be used
30 to ensure that the network spectrum efficiency will not get
too low. This may also be used to make the stand-by time of
the MS longer.

New cell reselection parameters may also be broadcasted in System Information. These parameters will be transferred to the UTRAN/BSS from an O&M with other radio parameters.

- 5 When the mobile station is in the active mode, the Controller Element (e.g. the RNC of the BSC) needs subscriber LSA information in order to favour the LSA cells. This information may be copied to the controller element during call set-up and/or during inter RNC/BSC handover. A RRC
- 10 message and information element may be specified for the information transfer. The LSA information element shall identify the preferred cells, priorities of these cells and the local access indicator.
- 15 In order to reduce the amount of information transferred the message may include information of a LSA only, for example, if:
- the serving cell is a member of that LSA; or
 - one of the neighbour cells is a member of that LSA; or
 - 20 - the LSA is set as mandatory for active mode support (in the MS) and the LSA belongs to the MS Profile that is currently set and the RNC/BSS supports the LSA.

The Information transfer may take place at a call set-up any

25 time after a RRC connection has been established.

During the process of cell identifier determination (in a Cell coverage-based LCS) and with the active mode support, the cells belonging to a cell identifier set, e.g. for the

30 user's LSA purposes, may be favoured at the call set-up and/or when a handover is carried out. The relevant subscriber's LSA information will be available within the related network element, e.g. in a BSC, RNC, etc. The

relevant subscriber's LSA information will be transferred to those elements during the call set-up and external handovers.

In some embodiments the radio aspects of a telecommunications system are preferably hidden from the core network. For example, in a 3rd generation system a cell identifier should be mapped to a Service Area parameter to be transport over an Iu interface between a UTRAN network and the core network. As already mentioned, the Service Area may include one or several cells. The mapping can be accomplished either in the RNC/BSC, in a Network Management System (NMS, including Network Management Unit, NEMU) or by co-operation of various access network elements. In order to determine a cell coverage estimate and to map it to the Service Area parameter, parameters such as the best reference signal, a Round Timing Trip (RTT) between Base Station, Mobile Station, Location Measurement Unit (LMU), Reference Node Positioning Elements, , as well as antenna beam direction parameter may be utilised in association with the related cell identifier(s). In this case, the controller may use a reference signal round trip time (RTT) that is measured by the base station BS either periodically or on demand.

Based on the RTT measurement, the more accurate location estimates can be obtained by using so called Round Trip Time Difference (RTTD) principles. More particularly, the RNC or other network elements (or mobile devices) involved in the positioning calculation process may utilise the Round Trip Time Difference (RTTD) measured by base stations, Geometric Time Difference (GTD), and Real/Relative Time Difference (RTD). The DRTT can be calculated, for instance, in the RNC by using/comparing the RTT measurements accomplished by the corresponding base stations. The GTD on the other hand, can

be calculated by using the RTT measurements and the locations of the corresponding base stations. The RTD is the relative synchronisation difference in the network between two base stations and may be measured by a LMU (location measurement unit). In addition to that RTD may be calculated by utilising the network basic measurements. For instance, in UMTS, a Connection Frame Number (CFN) - System Frame Number (SFN) observed time difference, or SFN-SFN observed time differences may be applied for such purpose. The DRTT is based on the time difference in the rounding of the signals from the different base stations. If this difference between the mobile station MS and the base stations BS₁ and BS₂ is Δt and there is Line Of Sight (LOS) between the MS and the BSs, then the MS may be located on a hyperbola, that is:

$$d_1 - d_2 = c\Delta t \quad (2)$$

where

$$\Delta t = \left(\frac{DRTT1}{2} - \frac{DRTT2}{2} \right) \quad (3)$$

d_1 is the range from MS to BS₁,

d_2 is range from MS to BS₂, and

c is speed of light.

The DRTT can be measured with three different base stations and the MS is located in the intersection of these hyperbolas.

By use of the RTTD, GTD, and RTD concurrently the mobile station can be positioned by means of the intersection of the two hyperbolas obtained by the three base stations and the two GTDs. By utilising more GTDs it is possible to make the possible location area smaller. In a TDMA-based system, such as GSM, a corresponding RRT may be determined by so called

Timing Advance (TA) method. Therefore the concept of the above described DRTT method can be utilised also in TDMA-based systems by applying the Different Timing Advance (DTA).

- 5 The BS may measure the timing offset between the start of the downlink DPCH frame and the beginning (the first significant path) of the corresponding uplink DPCH frame. The accuracy of the measurement is preferably in a sub-chip level. The MS may provide additional time offset between its reception from and
10 transmission to the controller so that the exact RTT can be calculated.

Alternatively, the range of a cell may be determined by using a reference signal power budget. Based on the reference
15 signal power budget it is possible to obtain, e.g., the base station transmitted power, isotropic path loss, coverage threshold at coverage area border for a given location probability, and a cell range for an indoor and outdoor coverage.

- 20 In some cellular systems, such as in the CDMA, the cell range may vary in time, i.e. the cell size may increase or decrease in size depending on conditions such as the number of mobile stations connected to the cell. The cell range (radius) may
25 be estimated based on, for example, well known Okumura-Hata or any other appropriate approaches. The final cell radius may also be defined based on the following principle:

$$P_r = P_t - P_l = P_t - P_l(r_0) - 10n \log \left(\frac{r}{r_0} \right) \pm \Delta \log_{10} r \quad , \quad (4)$$

- 30 wherein P_r is the received power, P_t is the transmitted power (Equivalent Isotropic Radiated Power, EIRP) of the base station plus the receiver gain, P_l is the path

loss, $P_l(r_0)$ is the known nearby reference distance r_0 (e.g. 1km for a large urban mobile system, 100m for a micro-cell, and 1m for pico-cell), and r is the range from the base station. The last term depends on the
5 error correction due to the received power variation, MS mobility, and so forth.

The controller or the LCS node may use a reference signal link budget based cell range (radius) estimate in conjunction
10 with the cell identifier to make a coverage estimation for a service area.

Yet according to another option, the controller may use the observed time difference of System Frame Number (SFN-SFN) and
15 Connection Frame Number vs. System Frame Number (CFN-SFN) to determine either the cell range or the more exact location of the MS.

In any above-mentioned cases, the interaction between
20 neighbouring cell coverage areas, including the error margin, can be used to determine the more exact location of the mobile station.

If observed time difference of a SFS and CFN is employed in
25 refining the location estimate, then the location of the MS should be within an interaction area between neighbouring radio coverage hyperbolas. In addition to the latest cell identifier (LCS estimates), MS speed and direction can be utilised to map the cell identifiers to the corresponding
30 coverage area and/or service areas. Moreover, the radio network planning data, BS/MS reference power (transmitted and received), cell and/or base station layout, assistance data in the RNC/BSC/NMS (e.g. LCS data, transmit power control

data, etc.) may be utilised to map the cell identifier to the cell coverage and service area. The mapping may be done at the access network, and thus the LCS node may be provided with location co-ordinates. In other words, it is possible to
5 provide the core network element with a service area identifier that consist of location area co-ordinates.

According to one possibility the received power levels are compared against the power budget, whereby more accurate
10 information of the location of the mobile station may be provided. Computation made by two or more elements may also be combined.

Any combination of above mentioned approaches and measurement
15 parameters may be used in the embodiments of the present invention. The co-ordinates of cell coverage areas or service areas can also be defined in terms of circles, ellipsoids, polygons, etc.

20 Cell coverage-based (Cell-ID) location may meet requirements of most of the LCS services. The accuracy of the method may vary from some meters to some kilometers, depending on the cell structure of the system and the radio environment. These services may include location service categories such as:

- 25 - home or office indoors, wherein the cells are those that are provided by indoor base stations;
- home or office indoors and neighbourhood cells, wherein the localised service area (LSA) is broadened outdoors. The outdoor neighbour cells may be included into the local
30 service area for the indoor cells;
- industry area; wherein a company may have several office buildings and has a localised service area that covers all its buildings and outdoor areas in between;

- a part of the city or several locations within a predefined area.

The above already discussed some possible uses of the
5 location services. The following will describe in more detail
two examples of possible uses of the location service.

In the first example a user of a vehicle asks from the
location service for the nearest and/or cheapest gas filling
10 station within the area where he currently is located by
means of his mobile station or an in-vehicle navigation
system connected to a telecommunications system. The user is
located based on, for example, camping cell information,
whereafter information about the nearest available gas
15 filling point may be provided to him. The content provider
(in this case probably based at the gas filling station) may
also give guidance to the user that has requested the service
by means of the location service. The content provider may
even download a map of the area into the mobile station.

20

According to a further possibility the user may request the
service to initiate the fuelling of the vehicle (i.e. release
the pump or in automatic hose connection systems to connect
the fuel hose with the vehicle) by buttoning-down the gas
25 filling related button/option of the mobile station or the
in-vehicle navigating system. The mobile station may then
send a message to the gas station apparatus over an
appropriate media, such as an infrared link or blue-tooth
protocol. This message may include the customer information
30 needed for allowing the gas filling process, such as the
mobile number, mobile service profile code, international
mobile subscriber identity (IMSI), customer code offered by
the service provider etc. The customer information is checked

by comparing with the customer information available e.g. at a data base of the gas station, e.g. station's Virtual Home Environment. In the case of integrity, the automatic machine is acknowledged to trigger the fuel pump. Otherwise, the request is rejected and/or further information is requested from the mobile by sending a message from the gas filling data base to the mobile either directly or via the automatic machine responsible for fuel pump triggering. Consequently, the gas filling process can be started.

At the end of gas filling process, the user may also end the process by his mobile station. The gas filling related information is then sent to the station database for charging purposes. Based on this information user can then be invoiced. The charging can also be done directly by using mobile banking, that may include various modes of paying, e.g. cash, credit, using internet interface (e.g. Wireless Access Protocol), etc. or in conjunction with telephone billing.

In accordance with another example, a user asks for the nearest free and/or cheapest parking area within the area where he is driving. By using a mobile station or an in-vehicle navigation system he can process this e.g. by pressing a special parking button. As a result, the terminal is positioned and the information about the parking place is provided. He/she may be supported by a LCS-based follow me service. After the parking place has been found and the vehicle owner/user may park the vehicle.

The user may also request a reservation of the parking space by buttoning-down the parking related button in the mobile station or the in-vehicle navigating system. The mobile

interprets this as a mobile positioning request.

Consequently, a positioning request message is send to the cellular network. Then the terminal is positioned by the network (or terminal) e.g. based on the home cell and the
5 mobile location information is sent to the Mobile Location Center of the cellular system. This information may include the mobile station co-ordinates, time, parking related information (e.g. a predefined number/code that may be the vehicle's register number).

10

At the end of parking process, the vehicle owner may end the parking by pressing the parking button (ending). The mobile station may again interpret it as a location request and sends subsequently a message to the network. The mobile
15 station is positioned and the related information is sent to the Mobile Location Center. Mobile Location Center sends the mobile location information further to the traffic center of the municipality (or any service provider). This information includes, the co-ordinates of the mobile, time (including
20 both positioning attempts, starting and ending), parking related information. Traffic center can charge the vehicle owner based on the location (home cell) information of her/his mobile or in-vehicle navigation system. This may be done by comparing the mobile location information with the
25 corresponding parking zone and charging schemes. Similar charging approaches as in the first example can also be applied for this purpose.

It should be appreciated that whilst embodiments of the
30 present invention have been described in relation to mobile stations, embodiments of the present invention are applicable to any other suitable type of user equipment.

The location data may be transmitted in packet form. However, in alternative embodiments of the invention the data may be sent in any suitable format.

5 The embodiments of the present invention have been described in the context of a code division multiple access system. This invention is also applicable to any other access techniques including frequency division multiple access or time division multiple access as well as any hybrids thereof.

10

It should also be appreciated that base stations can sometimes be referred to as node B. In addition, the term cell is intended to cover also a group of cells in instances where more than one cell is controlled by a controller entity
15 (for instance a UTRAN routing area (URA) update). The URA handover corresponds substantially to the cell handover, the difference lying in the fact that URA forms a group of cells.

The above discusses the interface and communication between a
20 radio access network controller and a gateway location service node of a core network. Embodiments of the present invention can be applicable to other network elements where applicable.

25 It is also noted herein that while the above describes exemplifying embodiments of the invention, there are several variations and modifications which may be made to the disclosed solution without departing from the scope of the present invention as defined in the appended claims.

30

Claims

1. A method for use in a telecommunications system, said telecommunications system comprising a plurality of service areas, each of the service areas being identified by a service area identifier, the method comprising the steps of:
- requesting a service area identifier associated with a mobile station of the telecommunications system;
 - selecting one service area identifier from a plurality of possible service area identifiers in accordance with a predefined rule for the selection of the service area identifier; and
 - providing the location information based on the selected service area identifier.
2. A method according to claim 1, wherein each of the service areas comprises at least one cell of a cellular telecommunications system, each of the cells being identified by a cell identifier.
3. A method according to claim 1 or 2, wherein the telecommunications system comprises a core network, an access network for providing the service areas for the mobile station, and an interface therebetween, and the request for the service area identifier is initiated in the core network and the selection of the service area identifier is accomplished in the access network.
4. A method according to claims 2 and 3, wherein an element of the access network selects an identifier and provides a core network element with a service area identifier that is based on the selected identifier.

5. A method according to any of claims 2 to 4, wherein the service area identifier corresponds the selected cell identifier.
- 5 6. A method according to any of the preceding claims, wherein the service area identifier to be selected is the service area identifier generated when the station is paged.
7. A method according to any of the preceding claims,
10 wherein the service area identifier to be selected is the service area identifier generated during connection set-up proceedings between the mobile station and a base station of the telecommunications system.
- 15 8. A method according to any of the preceding claims, wherein the mobile station is located within a handover area between a first service area and a second service area.
9. A method according to claim 8, wherein the service area
20 identifier to be selected is the service area identifier of the second service area.
10. A method according to any of the preceding claims, wherein the service area identifier to be selected is the
25 service area identifier of the service area that provides the best quality signal connection for the mobile station.
11. A method according to claim 10, wherein the best quality signal is the strongest signal.
- 30 12. A method according to any of the preceding claims, wherein the service area identifier to be selected is the service area identifier of the service area providing the

shortest distance between the mobile station and a base station of the service area.

13. A method according to any of the preceding claims,
5 wherein the service area identifier is selected based on information of at least one localised service area.

14. A method according to claim 13, wherein the localised service area is one of the following list: an access only
10 localised service area; an exclusive access localised service area; a preferential access localised service area.

15. A method according to any of the preceding claims, wherein the service area identifier is selected based on a
15 priority order of the possible service areas.

16. A method according to any of the preceding claims, wherein at least two different rules are employed in the selection of the service area identifier.
20

17. A method according to claim 16, wherein the rules for the selection are provided in a priority order.

18. A method according to claim 16, wherein a predefined
25 rule is selected among the rules for the selection of the service area identifier in response to a predefined event.

19. A method according to claim 16, wherein the preference order of the rules is based on threshold values of the
30 selection parameters.

20. A method according to any of the preceding claims, wherein the service area identifier is requested by a location service node.

5 21. A method according to claim 20, wherein the selection of the service area identifier is accomplished at a network controller controlling at least one of the cells of the telecommunications system.

10 22. A method according to claim 20, wherein the selection of the service area identifier is accomplished at a base station of the telecommunications system.

15 23. A method according to claim 20, wherein the selection of the service area identifier is accomplished at a mobile station of the telecommunications system.

20 24. A method according to any of the preceding claims, wherein the location information that is based on the service area identifier is provided to an external client.

25 25. A method according to any of the preceding claims, wherein the location information that is based on the service area identifier is used by at least one application that implemented within the telecommunications system.

26. A method according to any of the preceding claims, wherein geographical location area co-ordinates are determined based of the service area identifier.

30

27. A method according to claim 3 or any claim that is appended thereto and claim 26, wherein the co-ordinates are

determined in the access network and transmitted to the core network.

28. A method according to any of the preceding claims,
5 wherein a forced selection of the service area identifier.

29. A telecommunications system, comprising:
a plurality of service areas, each of the service areas
being provided with a service area identifier;
10 a location service node arranged to requests a service
area identifier associated with a mobile station and to
provide location information concerning the mobile station
based on the service area identifier; and
selection means that are arranged to select one service
15 area identifier associated with the mobile station from a
plurality of possible service area identifiers associated
with the mobile station in accordance with at least one
predefined rule for the selection of the service area
identifier.

20
30. A telecommunications system according to claim 29,
wherein the location service node is located in a core
network of the telecommunications system and the selection
means are located in an access network of the
25 telecommunications system.

31. A telecommunications system according to claim 29 or 30,
wherein the selection means are comprised in an access
network controller.

30
32. A telecommunications system according to claim 29 or 30,
wherein the selection means are comprised in the mobile
station.

33. A telecommunications system according to claim 29 or 30,
wherein the selection means are comprised in a network
element on the signalling path between the mobile station and
5 an access network controller.

34. A telecommunications system according to any of claims
29 to 33, wherein the selection means are arranged to select
a service area identifier based on one or several of the
10 following rules: select an identifier that associates with
the closest base station; select an identifier that was
generated during the previous connection set-up; select an
identifier generated when the mobile station was paged;
select an identifier that associates with the most recent
15 service area that associates with the mobile station; select
an identifier that associates with a service area providing
the best quality signalling path for the mobile station;
select an identifier that associates with a predefined
localised service area; select an identifier that has the
20 highest priority of the possible service area identifiers.

35. A telecommunications system according to any of claims
26 to 31, wherein the service area corresponds a cell of a
cellular telecommunications system.

25

36. A telecommunications system according to any of claims 29
to 35, comprising means for mapping the selected location
area identifier to a geographical location area expressed in
co-ordinates.

30

37. A telecommunications system according to any of claims
29 to 36, comprising positioning means arranged to provide
position information of the mobile station.

38. A telecommunications system according to claim 37,
wherein the positioning means are arranged to map the
selected location area identifier to a geographical location
5 area expressed in co-ordinates.

39. A telecommunications system according to claim 37 or 38,
wherein the positioning means are based on a techniques
selected from a list including the following techniques:
10 round trip time; round trip time difference; geometric time
difference; real time difference; relative time difference;
timing advance; or timing advance difference.

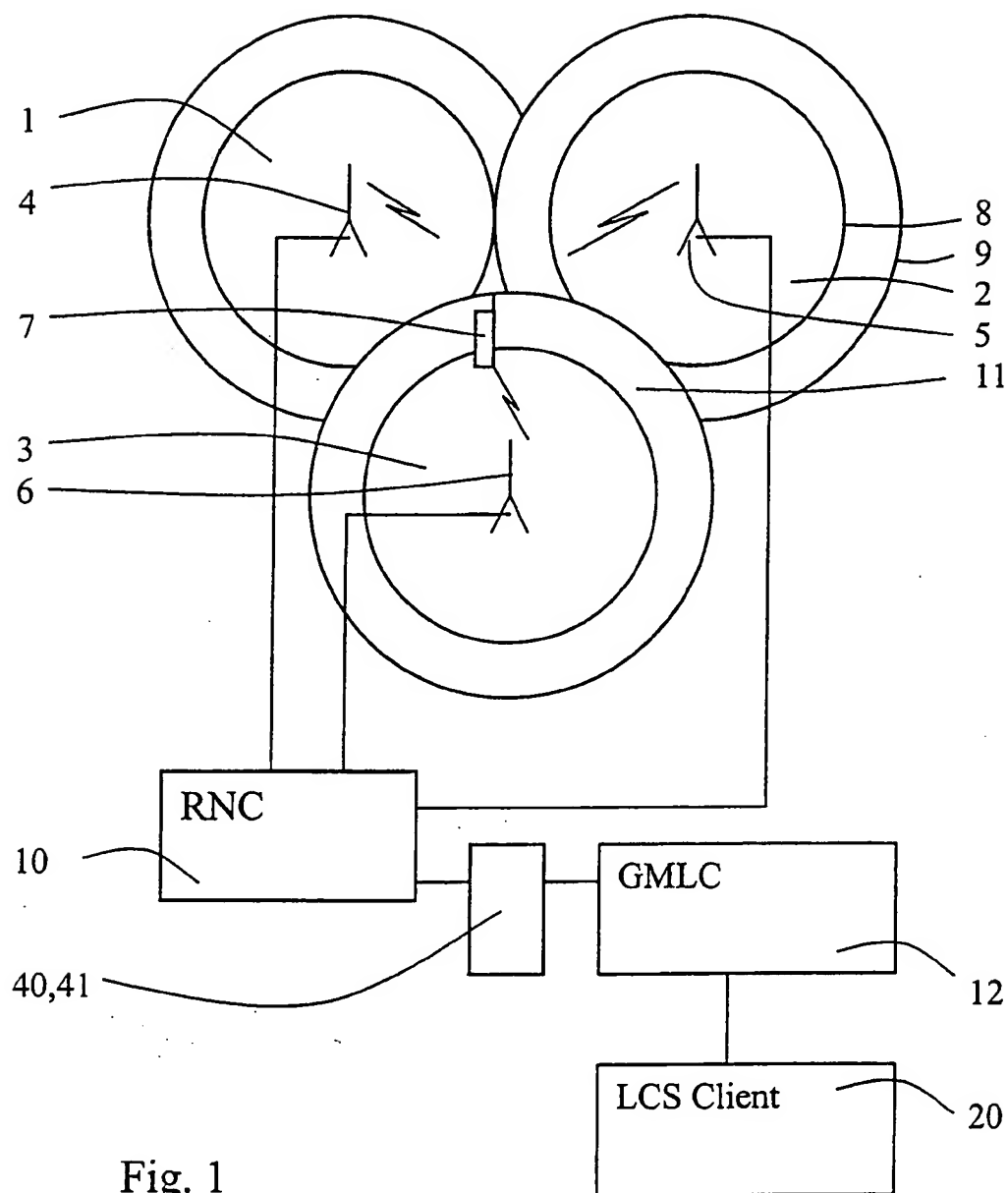


Fig. 1

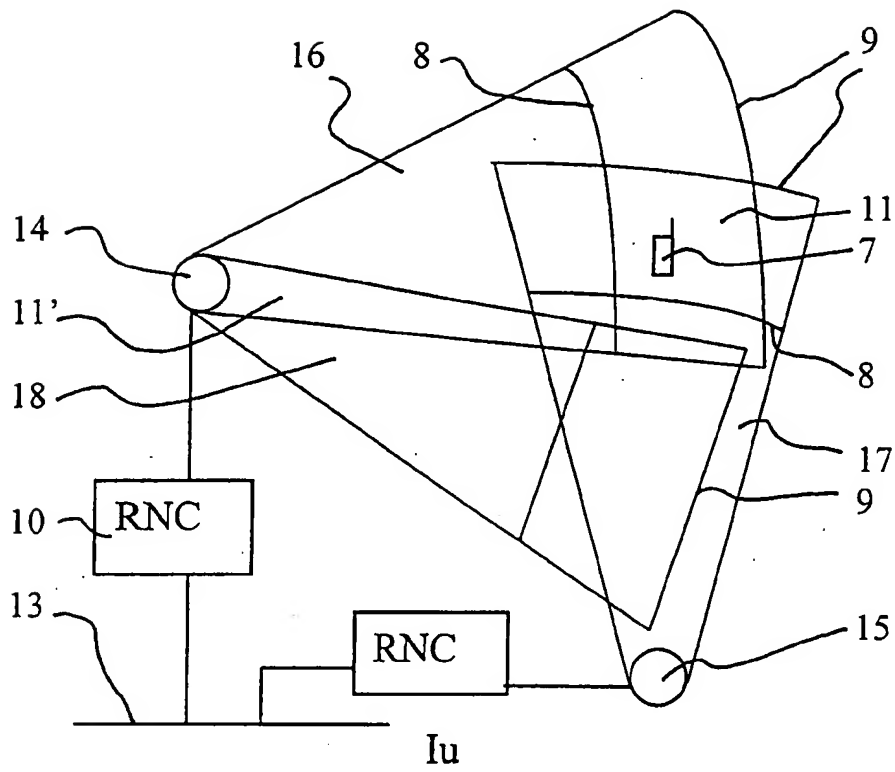


Fig. 2

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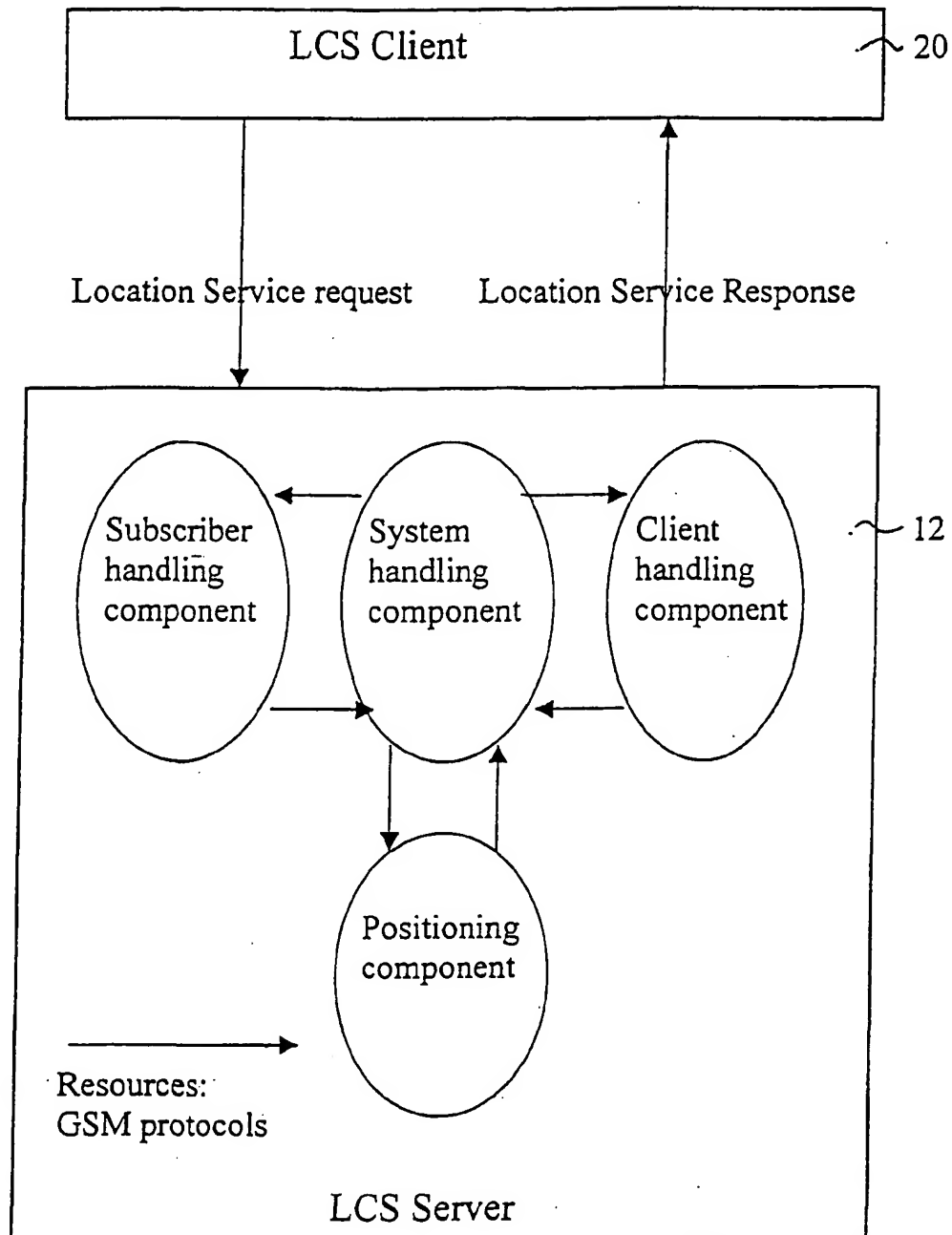


Fig. 3

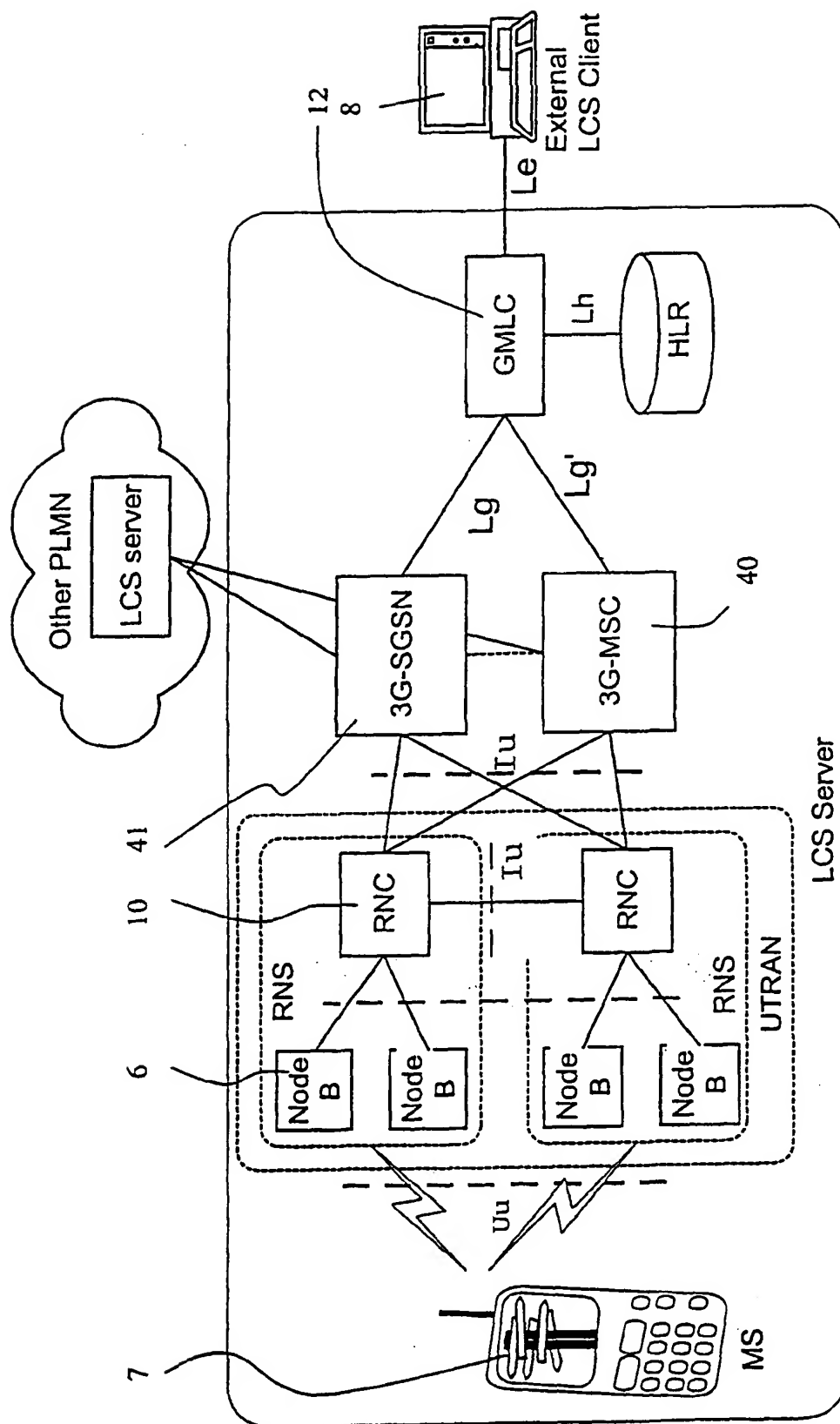


Fig. 4

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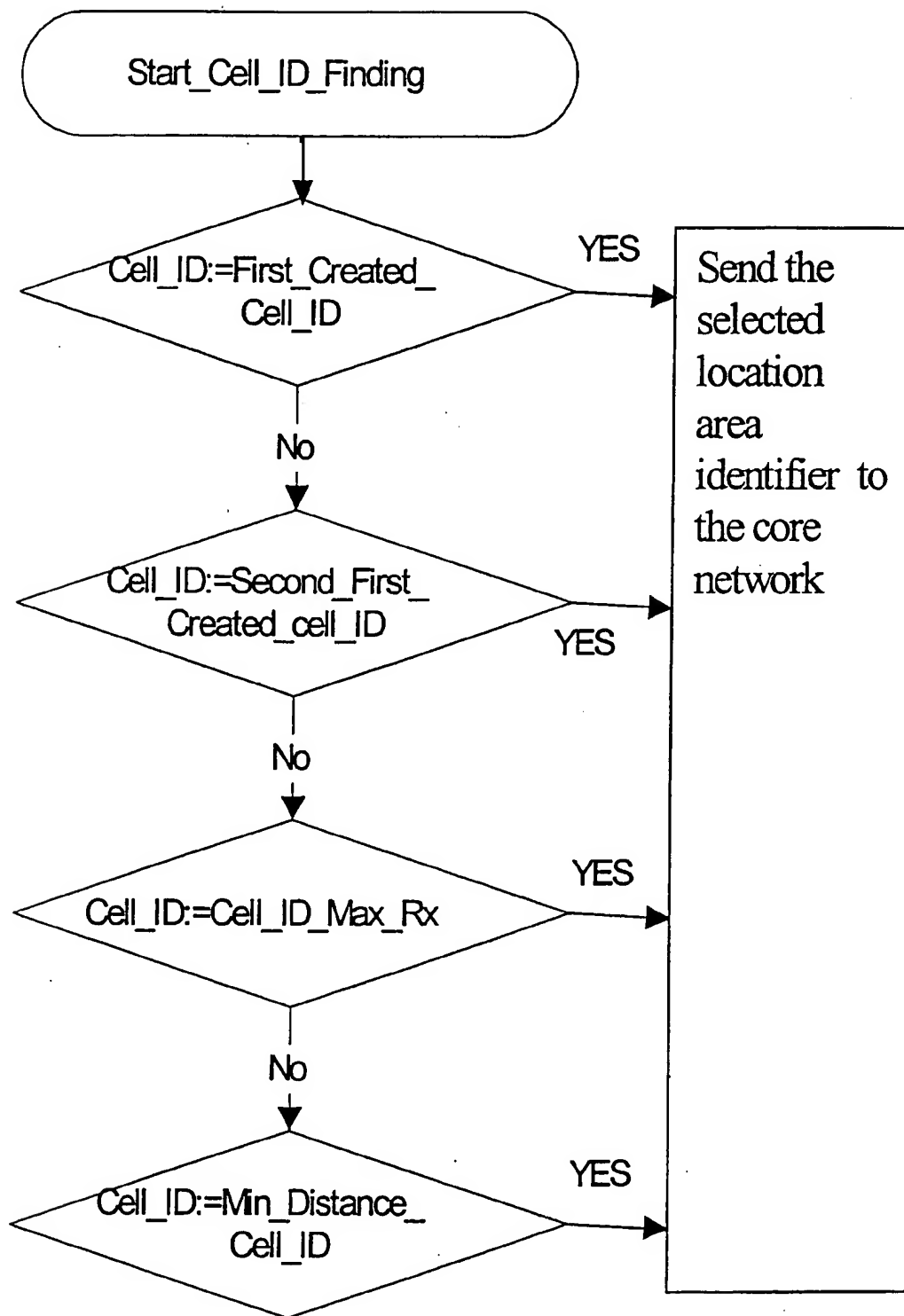


Fig. 5

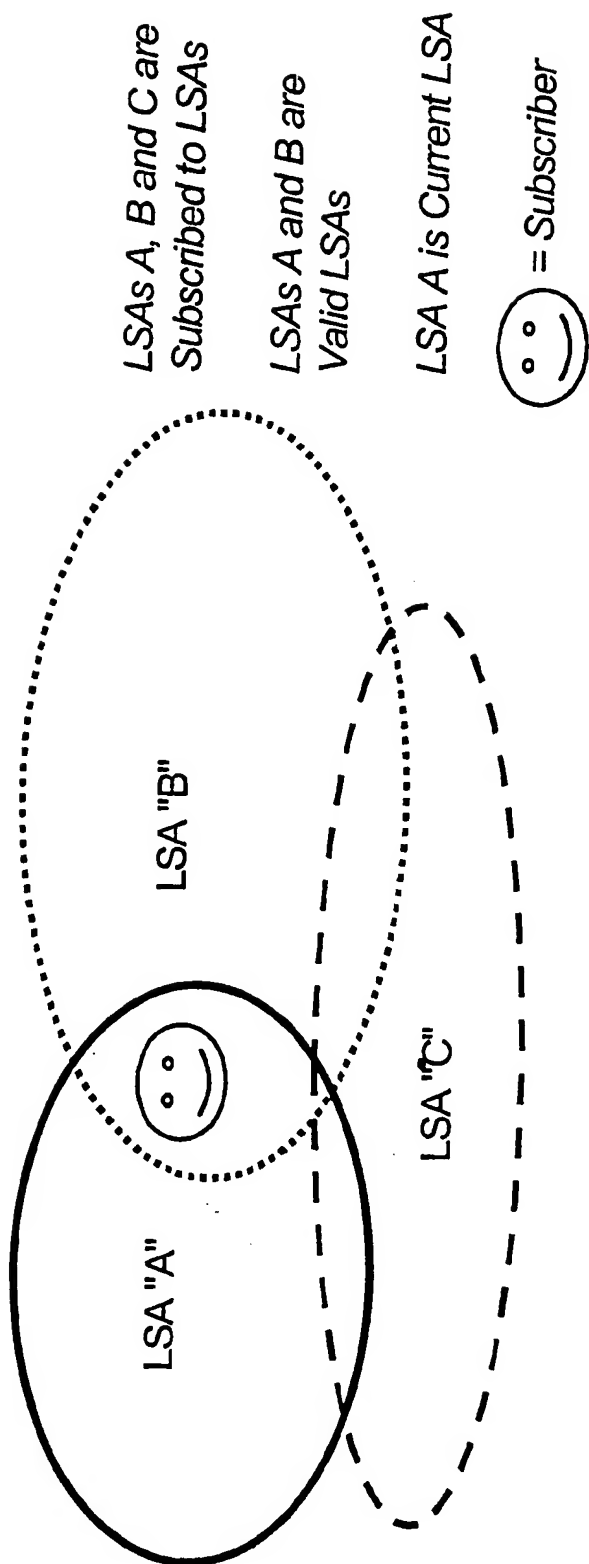


Fig. 6

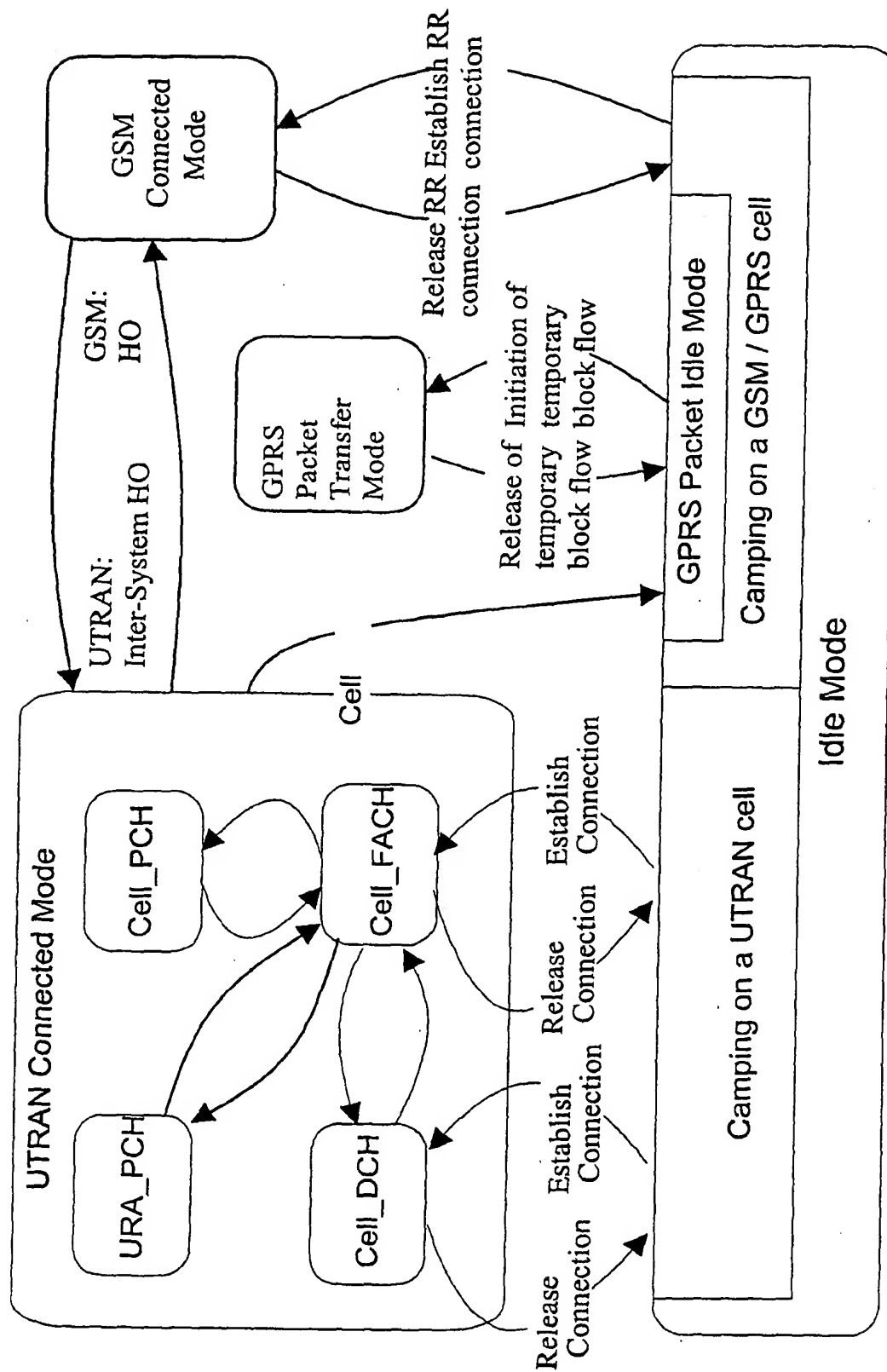


Fig. 7

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/13044

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 930 699 A (BHATIA RANJIT) 27 July 1999 (1999-07-27)	1-7, 13, 14, 24-28, 35 29-33
A	column 2, line 1 - line 45 column 2, line 57 - column 3, line 40 ---	
X	WO 99 52316 A (NOKIA TELECOMMUNICATIONS OY ; PUTKIRANTA PETTERI (FI)) 14 October 1999 (1999-10-14) page 5, line 11 - page 7, line 21 page 9, line 14 - line 26 page 10, line 9 - page 11, line 10 -----	1, 2, 5-7, 10-14, 16-20, 23-27, 29, 32, 34-39

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

13 June 2001

Date of mailing of the international search report

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Authorizer: officer

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte. onal Application No

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